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of a "flood," also known as "flood fever," which has been employed in various mines in England, France, and Belgium. But this time the term was taken to mean quite something else, and it was not long before the infestation in the Grand Gravelles (G) was traced to the same source (balloons) was found in the mines of Belgium. The infestation was traced to a group of laborers who had been employed in the mines of Belgium during the summer and early fall. It was discovered that numerous infected workmen from certain Belgian mines were carrying the infestation into German mines. Whether or not this was the occasion of the first appearance of the infestation in German mines is not definitely known. It seems, however, very probable that anthrax disease was existed among miners in Belgium, France, and possibly Germany, for several centuries at least, the belief being that former epidemics of anthrax among miners in these countries were caused by anthrax infection.

in Berkey, (13) after the discovery above mentioned, steps were taken to control the anemia levels by means of filters of the distribution of sanitary conveniences and the treatment of the sick, incapacitated and anemic. The disease, however, continued to spread, and as a consequence, a complete anemic program was adopted in 1926, including the discovery and cure of all infected carriers whether ill, anemic, incapacitated or merely carriers. This, though expensive and time-consuming, has proved to be the best policy. In Austria, where incomplete measures only were attempted, anemia is said to have continued to exist among 20 to 99% of the population. The results achieved have been in proportion to the thoroughness of the control.



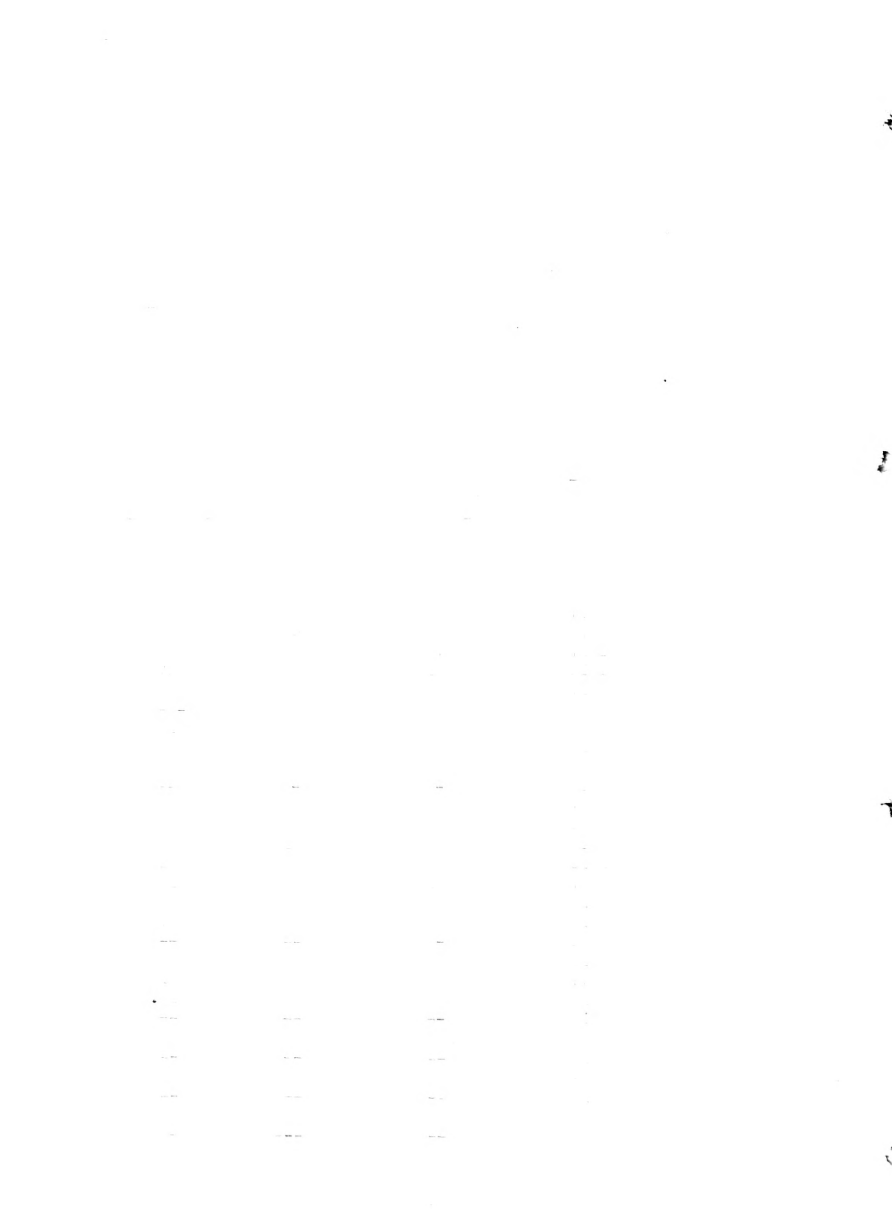
impractical to place the infected miners in a separate camp. It was, therefore, decided to limit the number of infected miners to the minimum. The infected miners were isolated in the Western Coal Mine, which is similarly situated in the Western Coal Mine hills of the Western Nevada, about 70 miles northwest of Carson City, in 1916, the request for a separate camp for infected miners was completed during the latter part of November, 1916, and resulted in the finding of but two infected miners out of a total of 1,000 workmen examined (one of these miners proved to have been infected in other localities).

In December, 1916, the infected miners were isolated in a separate camp to facilitate the resumption of our work among the infected miners. The remainder of this paper is concerned with a discussion of the influence of encephalomyelitis of hookworm disease in mines and the results of related observations and experiments made by the writer the winter and spring of 1916-17. Statistics as to the incidence of hookworm disease among men engaged in the various Western Coal Mines during the winter and 1917 are shown in the tables here appended. The significant reductions in percentages that appear so striking in some instances are not due primarily to the effects of treatment but rather to the high turnovers in the population, the general strike in the West in the fall of 1916. A re-examination of the infected miners was made before the strike and treated one or two times more and a considerable improvement in percentage of infected miners was observed. The data at the head of Table I and II in the Appendix are as follows:

$\frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} f(x) e^{-x^2} dx = \frac{1}{\sqrt{\pi}}$

[illegible]

Line	Year	1965	1966	1967
		1965	1966	1967
A	1916	189	88	89
	1917	195	81	11
B	1916	192	47	16
	1917	170	89	9
C	1916	171	124	67
	1917	191	21	2
D	1916	---	---	---
	1917	51	2	14
E	1916	57	22	19
	1917	52	21	46
F	1916	---	---	---
	1917	67	9	16
G	1916	56	13	27
	1917	46	1	2
H	1916	29	8	11
	1917	71	3	18
I	1916	121	49	78
	1917	114	6	7
J	1916	---	---	---
	1917	22	2	9
K	1916	53	26	31
	1917	76	11	14
L	1916	---	---	---
	1917	103	16	13
M	1916	---	---	---
	1917	22	1	3
N	1916	---	---	---
	1917	---	---	---
O	1916	---	---	---
	1917	---	---	---



F	1916	--	--	--
	1917	113	0	0
Q	1916	--	--	--
	1917	28	0	0
R	1916	--	--	--
	1917	34	9	26.5
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Total	1916	969	363	36.2 Av. percent for 8 mines
Total	1917	1770	195	11.9 Av. percent for 18 mines

-----Surface Workers-----				
<u>Mine</u>	<u>Year</u>	<u>Number Examined</u>	<u>Number Found Infected</u>	<u>Per Cent Infected</u>
A	1916	37	3	8
	1917	53	2	4
B	1916	--	--	--
	1917	94	2	2
C	1916	28	1	4
	1917	8	0	0
I	1916	--	--	--
	1917	--	--	--
D	1916	13	3	23
	1917	--	--	--
J	1916	--	--	--
	1917	14	0	0
E	1916	--	--	--
	1917	--	--	--
F	1916	18	2	11
	1917	12	0	0
G	1916	27	4	15
	1917	24	1	4
K	1916	--	--	--
	1917	17	1	6
H	1916	14	1	7
	1917	19	0	0
L	1916	--	--	--
	1917	15	1	6.5
M	1916	--	--	--
	1917	13	0	0
N	1916	--	--	--
	1917	27	0	0
O	1916	--	--	--
	1917	9	0	0
P	1916	--	--	--
	1917	60	0	0
Q	1916	--	--	--
	1917	12	1	8
R	1916	--	--	--
	1917	--	--	--
<hr/>				
Total	1916	137	14	11.3 Av. percent for 6 mines
Total	1917	377	8	2.1 Av. percent for 14 mines

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1. Temperature, relative humidity and ventilation.
2. Mine drainage and methods of collection and removal of mine water.
3. Chemical composition of mine water.
4. Mine sanitation with particular reference to feces and disposal.

TEMPERATURE, RELATIVE HUMIDITY AND VENTILATION - Under natural conditions, the most suitable temperatures for growth and apropagative development of hookworm embryos to the infective larval stage are between 65° and 85° F. (19° and 30° C.) Below this range of temperature growth and development are slow; above this range growth and development are rapid but the eggs, embryos and larvae are very apt to die. In the laboratory under artificial conditions, good results can be achieved if temperatures from 25° to 30° C. are maintained. The average temperatures of only a few of the mines, included within the scope of my observations and studies of hookworm infection among California miners, fell below a temperature generally considered necessary for normal growth and development of hookworm embryos and larvae. Similarly it may be said regarding both limits of temperature above mentioned that there was no mine in some parts of which conditions of both temperature and relative humidity were not favorable for the establishment of endemic foci, assuming all other necessary favorable conditions to have been present. As to relative humidity, it may further be said in general that the humidity in all these mines was uniformly high.

Without going into more detail under this heading it must suffice to state that effective ventilation tended, as it should be expected, to

materially reduce both the underground temperatures and relative humidities. However, good ventilation was the exception and not the rule in "Mother Lode" mines. Where ventilation was effective comparatively low degrees of infection among the men appeared to be the case.

METHODS OF COLLECTION AND REMOVAL OF MINE WATER - A study of mine drainage and methods of collection and removal of mine water proved to be most interesting and instructive. In addition to drainage along the floor levels of mines, it is necessary also to consider leakage from one level to another through fills and connections such as shafts, winzes and raises. These are all very important factors in the possible dissemination of larvae from infested localities. Whether the infective larvae are carried up and transported by water as it is drained off from infested areas or whether the collected drain water is supplied more directly with larvae hatched from ova-laden feces through the use of water collection devices for toilet conveniences, seemed to make little difference in the ultimate dissemination of larvae. Attempts to intercept hookworm larvae while being carried by mine drain water proved unsuccessful. However, periodic observations on the dissemination of larvae hatched from infested stools deposited along a mine drain gutter, as shown in illustration 1, indicate the important role which mine drain water may play in the distribution of infective larvae.

(11)

Boycott and Maldano, who investigated hookworm infestation among Cornish miners in 1907-1908, mention the use of the pail-cisterns by the men for receiving their evacuations and think "their use for this purpose less open to objection, since the feces are carried to the sur-

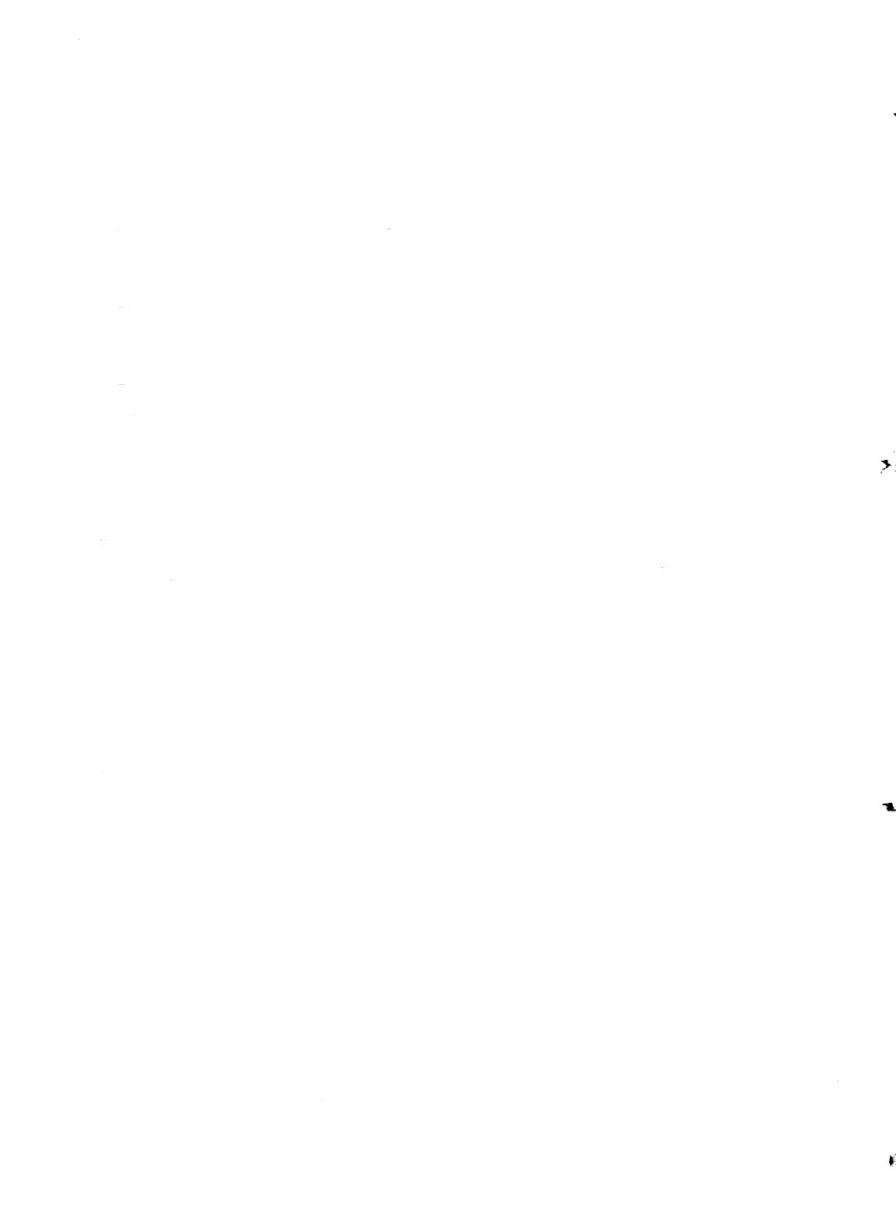
place where they can probably do no harm." They quote further that "running water is said to prevent, in any case, the development of ova." These statements are, however, contrary to my observations and experience. In mines where the pumps were in use, the highest degrees of infection were found to exist among the underground workmen. Likewise the clinical histories of cases pointed quite clearly to the infected pumps as the most probable sources of high degrees of infection among the workmen. Running water did not appear in any way to prevent the development of larvae from the ova. Furthermore, as already intimated, in addition to not preventing development of the larvae, running water undoubtedly serves both to distribute and collect larvae from points of origin. Evidence on this point will be presented a little later.

In case of one mine (Mine 3 in Table 11) situated in the very center of the endemic area, a comparatively low degree of infection was upon examination found to exist among the underground workmen engaged therein. Without a careful survey of past and present methods of feces disposal in conjunction with the particular method of collection and removal of the mine drain water, a satisfactory explanation of this apparent anomaly would have been difficult if not impossible. In brief, it was found that the men defecated into wooden tanks or exit-pipes leading from the mine, which were completely emptied at least once a day. The use of special water hoisting skips in a vertical shaft favored the removal of the water containing ova-laden feces with a minimum amount of shaft contamination. With these exceptions the circumstances incident to the operation of and conditions existing

in this mine were quite similar to those found in neighboring mines where a high degree of hookworm infection existed among the underground workmen.

CHEMICAL COMPOSITION OF MINE WATER - The relation of the chemical composition of mine water to the prevalence of hookworm infection among the workmen presented another interesting problem in my investigations. In case of two neighboring gold mines and a nearby copper mine which was also included within the sphere of our activities, surprisingly low percentages of infection were found among workmen engaged therein. Average samples of drain water from the two gold mines in question showed about 1% chlorine and a representative sample secured at the copper mine showed 1.6% chlorine as sodium chloride and a correspondingly high per cent of the sulphate radicle iron and copper.

During the course of their investigations in Cornish mines, Spcott and Haldane also found hookworm infection rare among the workmen engaged in one mine the workings of which extended beneath the sea and into which sea water percolated. Frequently specimens of drain water from this mine showed less than 1% of chlorine as sodium chloride. In discussing the action of disinfectants on hookworm larvae, these investigators (12) point out the necessity of carefully distinguishing the stages of growth of the larvae in question. Upon emergence from the egg, they are readily killed by comparatively weak germicides, but if given favorable conditions of temperature, moisture, abundant food supply and freedom from contact with deleterious substances until encapsulated in the second adult skins, then these so called "encysted larvae" manifest greatly increased powers of resistance to adverse conditions and substances.



According to both Lanuvrie (1) and Calbette (2), the water, containing as low as 1% sodium chloride appeared to have been effective in preventing the infestation of the soil in French mines. These authors differ, however, as to the practicality of artificially salting mines in order to prevent infestation of the soil. I am inclined to agree with Calbette regarding the impracticability of this procedure as an effective control measure on a large scale for the reasons: (1) That the rapid dilution of the sodium chloride by the mine drain water will not permit of the maintenance of a sufficient degree of concentration and (2) in view of the great total length of drifts and cross-cuts such practice would entail an expense out of all proportions to the object desired to attain. However, on a small scale, salting applied to limited localities will undoubtedly prove more or less effective. In order to secure more light if possible on the effects of the chemical environment on the hatching of hookworm ova and development of the larvae resulting therefrom, experiments were devised, approximating in so far as possible actual mine conditions. Accordingly, typical specimens of mine earth were collected which seemed to represent the variations in geological formation and mineral composition of ore and rock that it was thought might have a bearing on this problem. These earths, after being dried, were thoroughly sterilized by heat and employed in two sets of parallel culture experiments. In the one series suitable quantities of ova-laden feces and mine earths were intimately mixed and cultured in a moist condition at 25 and 30°C.; in the other series the feces mixed with some slack (Lobs action) were superimposed upon layers of the earth, the whole thoroughly moistened and

cultured in a similar manner. The results of these two series of parallel experiments seem to justify two conclusions: 1. That chemical mine soil environment as indicated by the chemical constitution of mine drain water exerts a marked influence on hatching, growth and development of hookworm larvae. 2. That where no poisonous substances are present in no great quantity the attainment of maturity (second moult or so-called encysted stage) is insured only when this stage is reached before contact with harmful substances. It is quite well known that hookworm ova and larvae in the encysted stage are quite resistant to adverse conditions as to chemical composition of the surrounding medium. This experiment is, however, too limited in scope to form the basis of any sweeping deductions, but it does appear to indicate at least that when the formations are of such a nature as seriously to load the drain waters with acid radicles such as chlorine or sulphate in combination with sodium, iron, copper, etc., that hookworm larvae will, with difficulty be able to reach maturity under natural conditions and the small percent which may arrive at the infective resistant stage will have less opportunity of surviving long.

MINE SANITATION WITH PARTICULAR REFERENCE TO FLEAS DISCUSS. It is an unfortunate fact that the great majority of responsible persons engaged in the mining industry, have failed until very recently to recognize the importance of under ground sanitation. Only comparatively few companies can boast of having given this matter the attention which it deserves until faced by an increasing prevalence of anemias due to hookworm infection. Even on the surface, the supply of toilets has frequently been most inadequate and crude. Some venting, although other

were in many instances expected to return to the surface to defecate when necessary, the usual result was that the men for sake of convenience and to avoid discomfort, especially in cold weather, would almost invariably resort to abandoned or unrepresented parts of the workings.

Such conditions and practice were far from the exception in "Mother Lode" and adjacent mines previous to 1916. In some instances, somewhat prior and in most cases subsequent to this time, very important improvements in the disposal of feces had been introduced into many of these mines. However, there still remains much to be desired in the way of more careful attention to details and the enforcement of sanitary rules. There are nevertheless notable exceptions to this statement and the general tendency seems to be in the desired direction. The greatest difficulty, encountered on the part of mine superintendents and foremen desirous of doing all possible to minimize fecal contamination of mine soil, is the periodic collection and removal of accumulated excreta by transport to the surface. Most men are unwilling to do such service even when inducements such as extra pay or shortening of time on duty are offered.

In England (18), it was thought that simple prophylactic measures sufficed to eliminate ankylostomiasis as an "industrial inconvenience" among miners. The scare, it is said, accomplished the greatest good in bringing much needed improvements in mine sanitation and thereby safeguarding the future. It is furthermore believed that the outbreak in Cornwall proved the general immunity of most mines in England since there had been free and frequent interchange of men between the infested mines and mines located elsewhere in England. It is also contended that "As far as the infested mine itself is concerned, it does not seem

that the benefits which have been gained in Westphalia (Germany) are greater than those in Cornwall to a degree at all commensurate with the enormous sums of money which have been spent on medical examination and treatment and the payment of wages to men under treatment." It is admitted, however, that the German system has the great advantage within a few years of largely reducing the number of men capable of carrying the infection to fresh places.

Circumstances and conditions regarding ankylostomiasis among California miners are in many respects similar to those reported from England. The description of Cornish mines as given by Boycott and Haldane in writing of their investigations, would with slight alterations serve quite well as a general account of "Mother Lode" mines. Likewise, the limited prevalence of the disease and the ease of reduction of incidence by the application of sanitary measures afford striking parallels. Regarding the freedom of other groups of mines of California, we have not full information, but sufficient data have already been collected to justify the statement that the disease had probably only secured an endemic foothold in some of the deep "Mother Lode" mines. No evidence of endemicity elsewhere in the state, either in mines or on the surface, has been found. State officials who are familiar with mines throughout the state, report conditions more or less unfavorable except in "Mother Lode" mines. Likewise, the examination of selected groups of workmen in a number of instances lends further support to this statement.

RESULTS OF OBSERVATIONS AND EXPERIMENTS IN MINE "A"

1. DISSEMINATION OF LARVAE IN MINE. Notwithstanding the rigid discipline regarding the use of underground commodes in this mine, it was found that men occasionally resorted, for toilet purposes, to unfire-

quented parts of the mine when convenient and detection seemed unlikely. Illustration 11 is typical of such excretions. In one particular cross-cut stools were on several occasions found deposited at intervals along one edge of the drain gutter, as depicted in illustration 1 already referred to. Upon microscopic examination, several of these were found to contain an abundance of hookworm ova. At regular intervals subsequently, samples were taken from these stools, from the surrounding earth and sediment deposited along the edges and bottom of the drain gutter both above and below the sites of excrement. The nematode larvae obtained therefrom were observed from time to time and compared with those derived by culture from the stools as originally found, i. e., before larvae had been hatched from the ova.

The method employed for the separating of hookworm larvae from mine earth, consisted in placing the earth to be examined upon a medium ribbed paper filter and leaching with warm water from time to time, permitting slight drying during the intervals. This seemed to be a fairly satisfactory method of securing the desired segregation of hookworm larvae. As to just how effective this method may be, I cannot state since no attempt was made to determine this point. However, this may be, I had no difficulty in obtaining hookworm larvae from mine earths by persistent leaching with warm water. Several common earth nematode larval forms also came through the filters quite readily but little difficulty was experienced in identifying the hookworm larvae.

These observations showed that under the most favorable conditions which was the case in this cross-cut, the larvae are hatched out from hookworm ova in a few days and soon leave the stool, being found in the moist parts of adjacent surroundings, particularly close to the edges

of the drainage gutter and frequently in the fine sediment accumulated on the bottom of the same. In all instances such larvae had apparently already reached the end of the second moult stage. They were sometimes quiescent and at other times they were quite active in their movements. Concentrated light and heat appear to stimulate active movement.

As time goes on, one may demonstrate the presence of hookworm larvae at increasing distances down stream from the point of origin. Thus it can readily be understood how in a comparatively short time, thousands of hookworm larvae originating from a single stool may be scattered along drain gutters and eventually reach the shaft where they may accumulate in the water catchment and storage devices or be scattered still farther following the water in its course to lower levels in the mine. It can also be easily appreciated that transport of such infested drain waters to the surface in open "skips" may soon result in serious infestation of the entire shaft where sufficient dampness exists, which is the rule.

These being the possibilities of mine soil infestation, resulting from one limited focus of infestation in the mine, what must be the sum-total resulting from promiscuous defecation in a large mine with its many ramifications of drift, cross-cut, raise and stops? Such conditions previously existed in "Mother Lode" gold mines. Owing to circumstances and conditions highly favorable to the establishment and maintenance of endemic foci in some of these mines, hookworm infestation of the soil early became established. These facts enable us to account for the reputation which mention of the "Mother Lode" mining district seems in general to have carried among miners and also to understand why the rank and file of men employed therein were drawn more largely from classes of foreign mine workers who are not at all careful about their personal habits.

2. INFECTION OF PUPPY DOGS - As an ultimate means of determining the presence, identity and infective nature of hookworm larvae obtained from earth collected in infested mines, an attempt was made to infect very young puppy-dogs in the abandoned cross-cut in Mine "A" where the observations just described were made. These animals which were of the fox terrier breed, were upon several occasions repeatedly exposed to mine soil thought to be infested with hookworm larvae.

Shortly after the arrival of the half dozen puppy-dogs secured for the conduct of this and several other experiments, distemper unfortunately manifested itself among them. The two fox terriers appearing to be in the best condition were selected for this crucial experiment. The one lived but 12 days after the last exposure in the mine, while the other survived 29 days. At autopsy in case of the former, a small immature nematode worm was found in the upper half of the small intestine. This specimen showed clearly the two pairs of teeth characteristic of *A. duodenale*. The latter animal gave the following post-mortem findings.

"Rigor mortis not yet set in. Slight sub-acute inflammation of stomach and duodenum. Both lungs consolidated. All other organs in apparently normal condition. In the middle one-third of the small intestine, there were found five hookworms (one male and four females), which are but one-half the usual size. However, microscopic examination shows mouth parts of all and the bursa in case of the one male to be well developed." (These five specimens have been identified by Dr. W.M. Cort, formerly Consulting Helminthologist to the California State Board of Health, and subsequently by Dr. Allen J. Smith, Professor of Pathology in the Medical School of the University of Pennsylvania, as *Ankylostoma duodenale*. However, the females lack evidence of sexual maturity as

shown by absence of identifiable culture from the feces.

Judging from the length of time elapsing between infection and death in case of the second animal (approximately four weeks), it seems most probable that infection was by mouth. It is generally accepted that 6 to 9 or 10 weeks is required for complete development when larvae enter exclusively by way of the skin, while two or three weeks less time is required when they enter by way of the mouth. Furthermore, the state of growth in case of the one specimen secured from the experimental animal after 12 days can only be accounted for on the assumption that entrance of the original mature saprogastric larva was direct through the mouth of this animal.

The above experimental infection of puppies with *A. duodenale* proves conclusively that hookworm larvae, capable of infecting selected young puppies and beyond a reasonable doubt underground workmen also, were present in this cross-cut. Moreover, the similarity of general underground conditions and sanitation in other parts of this mine ("A") and contiguous mines justifies the further conclusion, based on analogy, that hookworm infection could be even more easily acquired by the underground workers (the natural habitat of the adult *A. duodenale*) as long as infected men continued unrestricted to commit nuisances in these mines or were permitted to defecate into the water catchment storage devices.

INFECTION AMONG SURFACE WORKERS

The existence of hookworm infection among brickmakers in Germany has already been referred to. Owing to the low temperatures existing during the winter months, reinfection of the brickfields was usually necessary at the beginning of each warm season. As a consequence of this and other circumstances, connected with brickmaking, the earth infestation appears to have been a localized one, affecting principally

those employed in the brickfields or others whose occupations necessitated tramping over the same areas as was the case with carpenters at times according to Leichenstern.

At mines, infection among surface workers has been found to be relatively low both in Germany and along the "Mother Lode". European investigations state that not over 1% of infection has been found among surface mine employees at any time. During the period of my work, only one infection was discovered, the origin of which could not be traced to infested mines or known infested surface localities. As was the case in Germany, no instances of infection were found among the wives and children of miners in California.

The variable temperature, generally low humidity, abundant sunlight and comparative sparseness of shade throughout the gold mining districts in the Sierra Nevada foothills, are all factors operating against the establishment of endemic foci on the surface in the neighborhood of mines. There was not lacking, however, a supply of infective larvae discharged with drain waters from infested mines during 1916 and 1917 and previous years. In some cases, such mine drain waters had been used for irrigating gardens, and it seemed that under such circumstances some infestments of the soil might reasonably have been expected. However, such practice was the exception and not the rule. If, on the other hand, such infested mine drain waters had been used extensively for irrigation, some infections would have most probably developed among others than miners during the growing season. As a matter of fact, mine drain waters were almost invariably discharged into the small streams, together with the stamp mill "tailings", which are heavily laden with pulverised rock. The latter accumulates along the banks of the streams in fine deposits

which are quickly dried and are found, with great frequency, in the existence of hookworm larvae carried down with the heavy sediment and firmly incorporated in the urinal and gardening deposits of the mine.

IDENTITY OF SUBJECTS.

Owing to the lack of control over the patient during the course of treatment, it was found very difficult to secure specimens of the adult worms being passed. However, during the re-survey in 1917, an attempt was made to collect adult worms from selected men employed in some of the mines. When given the series of doses of medicine with directions as to when and how to take them, the patient was also supplied with a gauze net (medium mesh) about 14 inches square which was provided with a string of about the same length, attached to each corner. These strings were secured to opposite ends of two small sticks, each about ten inches long, which were intended to serve as handles with which to lift the net and contents from the bowl of the toilet and wash the bulk of the feces collected through the meshes with water by alternately elevating and lowering the handles over the bowl of the toilet. In case of one mine, where there was a dispensary situated near the boiler for the main shaft, the placing of the net in the bowl of the toilet and manipulating of the same with water afterwards was done by an attendant, the vermifuge having been administered by the mine physician. Where the treatment was taken by the individual at home, he was instructed how to use the net and told to wrap it (wet) securely in heavy paper after washing as directed and return it the following morning to a place designated at the mine.

In this way, during the winter and spring of 1917, 70 adult specimens were secured from 14 different miners. One of these was a Castilian, who had left Spain only four months previously. He showed a very marked

anemia and his first stool after treatment contained 1000. Only five specimens of *A. duodenale* were separated. Only one specimen of *Necator americanus* (female) was secured, and this came from a patient showing a number of male specimens of *A. duodenale*. This would seem to indicate quite clearly that the prevailing species was *A. duodenale* and that *N. americanus* only occurred in an occasional case. Out of the 63 identifiable specimens, 79 were found to be males and 24 females, thus giving a decided predominance of males. The largest number of specimens secured from one individual was 20, which indicates the comparative low degree of infection existing among the men at this time. During the course, however, of the first diagnostic survey made by Cumming and White in 1916 and previously according to the testimony of local mine physicians and others, the infection must frequently have been much more severe, judging both by the accompanying anemias and number of adult worms, said to have been found in the stools passed after the administration of the vermifuge, which was tapeworm in practically all cases treated at those times.

REVIEW OF TREATMENT.

The marked reduction in both the total percentages of men infected and the severity of individual infections already alluded to which occurred during the interval of six months elapsing between the diagnostic surveys of 1916 and 1917, may be attributed largely to changes in and instability of labor brought about by the general strike which occurred during the fall of 1916. Treatment of infected men could have had comparatively little influence as a factor in bringing about this reduction, since only a small percent of infected men submitted to treatment which could not be controlled owing to the lack of authority and disciplinary facilities. The rapid turnover

in the personnel resulting from the voluntary and involuntary exposure of old, highly infected employees, and the importation of new blood (largely free of infection) does, however, in my opinion, constitute the most important factor, which will supply an adequate explanation of these quantitative differences in diagnostic results and apparent therapeutic success, otherwise most difficult to account for. The method of diagnosis, namely centrifugation as described by Curding (10), was followed in all cases. This is by no means faultless as shown by frequent comparisons with the direct slide and the Loos cultural methods. However, the possible discrepancies are not serious when large numbers of examinations are being made as has been shown by contrasting the results of the 1916 and 1917 surveys with those of subsequent surveys made in both the "Grass Valley" and "Mother Lode" mining districts. In the latter diagnostic surveys the culture method was used almost altogether, but actual statistics are not available to the author.

Regarding treatment following the re-survey made by me in 1917, nothing of an encouraging nature can be said since it was conducted as before but with less apparent success. Later Angiostomiasis occurring among miners of California was made a compensable disease by the State Industrial Accident Commission and the management of the State Insurance Fund agreed to treat all discovered cases under supervision until cured of the infection.

SUMMARY AND CONCLUSIONS.

1. Anemia formerly so common among "Mother Lode" miners in California has been shown to be due almost exclusively to hookworm infection.
2. The California State Board of Health, in cooperation with the Federal Bureau of Mines, undertook a systematic survey of "Mother Lode"

It was proved subsequent to infection of the children that the locality that harbored larvae capable of penetrating the human duodena were actually present in the mine soil.

7. Ankylostomiasis among California miners was centered largely in a few of the deepest ball mines situated along the section of the "Mother Lode" in Amador County.

8. Surface infection did not exist in the vicinity of "Mother Lode" mines since practically all cases of ankylostomiasis discovered among surface workers were traceable to contact in mines with infected mine soil or drain water.

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